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FLAMEPROOFING COTTON FABRIC WITH THPC[1/]

A rather unusual chemical compound has been found which can be applied in combination with other chemicals to cotton fabric to make it permanently flameproof. This crystalline compound is tetrakis(hydroxymethyl)phosphonium chloride, $(HOCH_2)_4PCl$, abbreviated "THPC". It is made by reacting phosphine with formaldehyde and hydrochloric acid. As a result of current interest in its possible use as a flameproofing agent, at least one commercial company [2/] is now making THPC on a pilot plant scale and can supply it for experimental use. It is expected that THPC can be made on a large scale at a price low enough to permit it to be used commercially as a flameproofing agent.

In the flameproofing of cotton fabric, THPC is mixed with methylolmelamine and urea in aqueous solution. Triethanolamine is added to neutralize any acids that may be present. All of these chemicals are commercially available. Methylolmelamine is a chemical used in the creaseproofing of fabrics and is sold under several trade names.

An aqueous solution of the above chemicals was applied to the fabric with a microset laboratory padder with a tight nip roll pressure to keep the wet pickup at a minimum. It is often desirable to use two dips and two nips in this operation. The fabric is then dried at a relatively low temperature, cured at an elevated temperature and washed by any of the usual washing procedures.

The process is illustrated by the following description of a typical laboratory-scale application to cotton fabric:

A. Preparation of solution:

(1) 170 g. of THPC were dissolved in 170 g. of water, then the pH was adjusted to 6.8 with triethanolamine (35 g.).

1/ THPC is one of several flameproofing treatments being investigated by the Bureau of Agricultural and Industrial Chemistry's Southern Regional Research Laboratory in cooperation with the Quartermaster Corps to develop a flameproof fabric for military clothing.

2/ The Oldbury Electro-Chemical Co., Niagara Falls, N. Y., produces this chemical. This information is given for your convenience with the understanding that the Department of Agriculture does not endorse the products of one company over those of others.

(2) 105 g. of urea and 105 g. of methylolmelamine were dissolved in ~~515~~ 415 g. of water.

B. Padding:

Solutions (1) and (2) were mixed and 800 g. of 8-oz. O.D. twill (22 feet of 18 inch fabric) was padded using 2 dips and 2 nips with a tight squeeze roll setting. The wet pickup was 66%.

C. Drying:

The fabric was dried by passing it through an oven at 185° F. The fabric was in the oven for 4 minutes.

D. Curing:

Fabric was cured by passing it through the oven at 285° F. It was in the oven for 4 minutes.

E. Washing and Drying:

The fabric was washed in hot and cold water using a winch, then dried by passing it through the oven.

F. Properties of the Treated Fabric:

The flameproofed fabric contained 16% resin which will withstand repeated severe laundering or dry-cleaning. The treated fabric did not burn when held over an open flame, and when the flame was removed it did not glow. Treated fabric retained about 75% of its original warp tear strength and 100% of its original warp tensile breaking strength. A considerable amount of wrinkle resistance was introduced into the fabric by the flameproofing treatment. Char length in standard vertical test was 4.2 inches.

Experimentation has shown that the formulation illustrated by the above example may be varied widely and still give a flameprocfed fabric. The presence of urea in the solution is necessary to give satisfactory tear strength. In general, there is some loss in tear strength, but this is not unusual for resin-treated fabrics. Flameproofing that will pass the standard vertical test is obtained on 8 oz. twill at about 13 percent add-on. Lesser degrees of flame-retardancy may be obtained in lower add-ons. The curing conditions may be varied widely, but when lower temperatures are used the curing time must be longer.

Due to the loss in tear strength that accompanies the above process in its present form, it is not recommended for work clothing or for other uses where tear strength is of prime importance. It is believed to be applicable to curtains, drapes, and other household fabrics.

Recent experiments have indicated it is possible to greatly reduce or eliminate the loss in tear strength at the sacrifice of the crease-resistance, and work is in progress on a modification of the process along these lines.

The preparation of resins and polymers from THPC and their use in flameproofing fabrics is covered by patent applications assigned to the Secretary of Agriculture.